

FORM PTO-1390 (Modified) (REV 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER	
		TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		220644US0PCT	
INTERNATIONAL APPLICATION NO. PCT/JP00/06507		INTERNATIONAL FILING DATE 22 September 2000		U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 10/088101	
				PRIORITY DATE CLAIMED 22 September 1999	
TITLE OF INVENTION SURFACE-MODIFIED FINE SILICA POWDER AND USE THEREOF					
APPLICANT(S) FOR DO/EO/US Hirokuni SHIRONO et al.					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31). <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2)) <ol style="list-style-type: none"> <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). <input checked="" type="checkbox"/> has been communicated by the International Bureau. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). <ol style="list-style-type: none"> <input checked="" type="checkbox"/> is attached hereto. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) <ol style="list-style-type: none"> <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). <input type="checkbox"/> have been communicated by the International Bureau. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. <input checked="" type="checkbox"/> have not been made and will not be made. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)). <input checked="" type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409). <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210). 					
Items 13 to 20 below concern document(s) or information included:					
<ol style="list-style-type: none"> <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. <input type="checkbox"/> A substitute specification. <input type="checkbox"/> A change of power of attorney and/or address letter. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). <input type="checkbox"/> Certificate of Mailing by Express Mail <input checked="" type="checkbox"/> Other items or information: Notice of Priority/ Form PTO-1449 					

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR 107088101	INTERNATIONAL APPLICATION NO. PCT/JP00/06507	ATTORNEY'S DOCKET NUMBER 220644US0PCT	
24. The following fees are submitted:		CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :			
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO		\$1040.00	
<input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO		\$890.00	
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO		\$740.00	
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)		\$710.00	
<input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)		\$100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =		\$890.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)).		□ 20 <input checked="" type="checkbox"/> 30 \$130.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	8 - 20 =	0	x \$18.00 \$0.00
Independent claims	1 - 3 =	0	x \$84.00 \$0.00
Multiple Dependent Claims (check if applicable).		<input type="checkbox"/>	
TOTAL OF ABOVE CALCULATIONS =		\$1,020.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.		\$0.00	
		SUBTOTAL =	\$1,020.00
Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)).		□ 20 <input type="checkbox"/> 30 + \$0.00	
		TOTAL NATIONAL FEE =	\$1,020.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).		<input type="checkbox"/>	\$0.00
		TOTAL FEES ENCLOSED =	\$1,020.00
		Amount to be: refunded	\$
		charged	\$
a. <input checked="" type="checkbox"/> A check in the amount of \$1,020.00 to cover the above fees is enclosed.			
b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.			
c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0030 . A duplicate copy of this sheet is enclosed.			
d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.			
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.			
SEND ALL CORRESPONDENCE TO:			
<div style="border: 1px solid black; padding: 10px;"> <p style="text-align: center;">Surinder Sachar Registration No. 34,423</p>  <p style="text-align: center;">22850</p> </div>			
 SIGNATURE			
Norman F. Oblon NAME			
24,618 REGISTRATION NUMBER			
<u>March 22 2002</u> DATE			

220644US-0PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF : :

HIROKUNI SHIRONO ET AL : ATTN: APPLICATION DIVISION

SERIAL NO: NEW U.S. PCT APPLN :
(Based on PCT/JP00/06507)

FILED: HEREWITH : :

FOR: SURFACE-MODIFIED FINE
SILICA POWDER AND USE
THEREOF

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS

Please cancel Claims 1-12.

Please add the following new claims:

13. (New) A surface-modified fine silica powder having a high adsorbing ability for an anion source compound,

wherein said powder is obtained by a surface-modified treatment process comprising that more than 10mmol of a treating agent containing an amino group is added under dry-process in nitrogen atmosphere to 100g of the fine silica powder which is a fumed-silica obtained by a flame hydrolysis method, having the specific surface area of 50 to 400m²/g by

the BET method; and after holding the reactant under heating and vigorous stirring, the obtained powder has been surface-modified, and

wherein the adsorption amount of the anion source compound which is a sulfonate or a carboxylate, to the surface-treated fine silica powder is more than 150% of that of the original powder before the surface-treatment.

14. (New) The surface-modified fine silica powder according to claim 13, wherein the nitrogen content is 0.3 to 1.0%, and the adsorption amount of sodium benzenesulfonate is 15 to 60%, after the surface-treatment.

15. (New) The surface-modified fine silica powder according to claim 13, wherein the adsorption amount of the anion source compound is made to more than 150% of that of the original powder before the surface-treatment, by surface-treating with a treatment reagent containing amino group comprising the organic silicon compound having hydrolysis group or silanol group combined with silicon atom, and at least one amino group.

16. (New) The surface-modified fine silica powder according to claim 15, wherein the surface treating is done by using one or more of the treatment reagent containing amino group is an organosilane shown in the general formula [1] of $(R1)_n(R2)SiY_{(3-n)}$, where R1 is a monovalence hydrocarbon group, R2 is a hydrocarbon group containing more than one amino group, Y is a hydrolysis group or a hydroxyl group, and n is 0, 1, or 2.

17. (New) The surface-modified fine silica powder according to claim 13, wherein said fine silica powder is hydrophilic, and is used as the material of the ink acceptor layer of the printing material.

18. (New) A low viscosity silica slurry comprising the fine silica powder according to claim 13, wherein the adsorption amount of the anion source compound is more than 150%

of that of the original powder before the surface-treatment, the specific surface area is 200 to 400m²/g by the BET method, nitrogen content is 0.3 to 1.0%, and the viscosity is 1 to 50mPa·s under pH of 3 to 6 and the silica concentration is 15 to 30%.

19. (New) A forming material of the ink acceptor layer containing 5 to 30% of the surface-modified fine silica powder according to claim 13.

20. (New) An ink jet printing material coated with the liquid comprising the material of the ink acceptor layer according to claim 19.

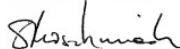
REMARKS

Claims 13-20 are active in the present application. Claims 1-12 have been cancelled.

Claims 13-20 are new claims. Support for the new claims is found in the original claims and in the specification, for example on page 10, lines 4-8. No new matter is believed to have been added by this amendment. An action on the merits and allowance of claims is solicited.

Respectfully submitted,

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Marked-Up Copy
Serial No:
Amendment Filed on:
<u>3-22-02</u>

IN THE CLAIMS

Claims 1-12 have been cancelled.

Claims 13-20 are new claims.

[TITLE OF THE INVENTION]

Surface-modified fine silica powder and use thereof

[Field of the invention]

Present invention relates to a surface-modified fine silica powder suitable as a material of an ink acceptor layer having the excellent printing effect, and its forming liquid or a printing material. Concretely, the present invention relates to the surface-modified fine silica powder having the excellent printing effect by being the adsorption amount of an anion source compound as an index and making its amount to more than a constant level, and its application to the ink acceptor layer. Especially, the surface-modified fine silica powder of the present invention is suitable as various printing materials for an ink-jet printing.

[Discussion of the background]

The ink acceptor layer has been coated on a surface of a recording paper used for printers of an electric instrument etc., in order to raise the printing effect, i.e. clear nature and fixing property etc. of ink. As a material of this ink acceptor layer, the materials having good fixing property without blotting with ink have been used, and the fine silica powder also has been used as one of said materials. However, when the fine silica powder is used for the ink-jet printer, which has been widely spread recently, the blotting with ink may occur on the surface of the recording paper at the time of printing, so that its improvement is acquired.

Although various surface-modified treatments has been conventionally known about the fine silica powder, it has been not known yet that the process, in which the printing effect is improved basing on the specific index about the surface-treatment. Therefore, when some surface-modified fine silica powders are used as the material of the ink acceptor layer, the printing effect cannot be improved sufficiently. Especially, in the printing materials used for ink-jet printing, sufficient effect may not be obtained.

Moreover, although the conventional fine silica powder has been used as a viscosity increasing reagent, when said fine silica powder is added to a coating material or printing ink etc., there are some problems in which the viscosity of slurry becomes high rapidly and the viscosity preparation becomes difficult when the much amount of fine silica powders is added.

[Object of the invention]

Present invention solves above-mentioned problems, and provides the surface-modified fine silica powder suitable as the material of the ink acceptor layer or the printing material etc. used for the ink-jet printing etc., by making the adsorption amount of the anion source compound as the index, and surface-treating until that said adsorption amount becomes more than the constant level. In addition, the present invention also provides the material of the ink acceptor layer or the printing material, which uses this surface-modified fine silica powder. Moreover, as a concrete example of the above-mentioned surface-modified fine silica powder, the present invention also provides the fine silica powder surface-treated with a specific silane

compound containing an amino group. Furthermore, with above-mentioned properties, when the surface-modified fine silica powder of the present invention is used to make the silica slurry, the silica slurry, in which the viscosity is remarkably lower than that of using the conventional fine silica powder and the flowability is excellent, can be obtained.

[Disclosure of the invention]

The surface-modified fine silica powder of the present invention is surface-treated, until that the adsorption amount of the anion source compound becomes more than 150% of that of the untreated original powder. By doing such surface-treatment, when said fine silica powder of the present invention is used as the material of the ink acceptor layer, the excellent printing effect being free from blotting with ink can be obtained. As the surface-treatment reagent, the treatment reagent containing an amino group is used suitably. As the anion source compound, a sulfonate and a carboxylate can be used. These acid salts are combined easily with the amino group induced on the surface of the fine silica powder by the surface-treatment, so that said acid salts are suitable as the index being the surface-treatment degree. Regarding the surface-modified fine silica powder of the present invention, it is preferable that fumed-silica having the specific surface area of 50 to 400m² / g by the BET method is used as the original powder. By using fumed-silica having this specific surface area, the surface-modified fine silica powder having high adsorption amount to the anion source compound, can be obtained.

The surface-modified fine silica powder of the present invention is surface-treated with the treatment reagent containing the amino group having a radical group, for example, an organosilane having a hydrolysis group or a silanol group with the amino group, in which said organosilane is shown in the general formula [1] of $R_1^n \cdot R_2SiY_{(3-n)}$ preferably. By using such treatment reagent containing the amino group, the hydrolysis condensation reaction between the fine silica powder and the surface-treatment reagent advances, so that the surface-modified fine silica powder having the amino group on the surface can be obtained suitably. Since this amino group is combined chemically with the silicon atom on the surface of silica, said amino group does not separate and change easily with the passage of time. In addition, by using more than two kinds of surface-treatment reagents containing the amino group, the amino group having different reactivity can be induced on the surface of the surface-modified fine silica powder. By inducing the amino group having different reactivity, the reactivity to the anion source compound becomes widely rather than the case of treating with the surface-treatment reagent containing one kind of the amino group, so that more kinds of the anion source compounds can be corresponded.

Moreover, the surface-modified fine silica powder of the present invention is surface-treated with the silane compound containing amino group, and the amino group having the amount of more than constant levels is induced on the surface of silica, so that the silica slurry having low viscosity also with high slurry concentration can be obtained.

That is, the present invention relates to the surface-modified fine silica powder comprising the following constitutions, and its application.

(1) A surface-modified fine silica powder for adsorbing the anion source compound,

wherein the adsorption amount of the anion source compound to the surface-treated fine silica powder is more than 150% of that of the original powder before the surface-treatment.

(2) The surface-modified fine silica powder according to above-mentioned (1),

wherein the anion source compound is the sulfonate or the carboxylate, and its adsorption amount is more than 150% of that of the original powder before the surface-treatment.

(3) The surface-modified fine silica powder according to above-mentioned (1),

wherein the anion source compound is sodium benzenesulfonate, and its adsorption amount is more than 15% of the additive amount to the fine silica powder.

(4) The surface-modified fine silica powder according to above-mentioned (1),

wherein the nitrogen content is 0.3 to 1.0% and the adsorption amount of sodium benzenesulfonate is 15 to 60%, after the surface-treatment.

(5) The surface-modified fine silica powder according to any one of above-mentioned (1) to (4),

wherein the adsorption amount of the anion source compound is made to more than 150% of that of the original powder before the surface-treatment by

surface-treating with a treatment reagent containing amino group , which comprises the organic silicon compound having the hydrolysis group or the silanol group combined with the silicon atom, and more than one kind of amino group.

(6) The surface-modified fine silica powder according to above-mentioned (5),

wherein the treatment reagent containing amino group is surface-treated with an organosilane shown in the general formula [1] of $(R1)_n \cdot (R2)SiY_{(3-n)}$, where R1 is a monovalence hydrocarbon group, R2 is a hydrocarbon group containing one or more amino groups, Y is a hydrolysis group or a hydroxyl group, and n is 0, 1, or 2.

(7) The surface-modified fine silica powder according to above-mentioned (6),

wherein 100g of the fine silica powder is surface-modified under dry process using more than 10mmol of one or more than two kinds of organosilane shown in the formula [1].

(8) The surface-modified fine silica powder according to any one of above-mentioned (1) to (7),

wherein the original fine silica powder is fumed-silica having the specific surface area of 50 to 400m² / g by the BET method.

(9) The surface-modified fine silica powder according to any one of above-mentioned (1) to (8),

wherein said fine silica powder is hydrophilic, and is used as the material of the ink acceptor layer of the printing material.

(10) A low viscosity silica slurry comprising the fine silica powder

according to above-mentioned (1),

wherein the adsorption amount of the anion source compound is more than 150% of that of the original silica powder before the surface-treatment, the specific surface area is 200 to 400m²/g by the BET method, nitrogen content is 0.3 to 1.3%, and the viscosity is 1 to 50mPa·s, under pH of 3 to 6 and the silica concentration is 15 to 30%.

(11) A forming material of the ink acceptor layer containing 5 to 30% of the surface-modified fine silica powder according to any one of above-mentioned (1) to (10).

(12) An ink-jet printing material coated with the liquid comprising the forming material of the ink acceptor layer according to above-mentioned (11).

[Best embodiment of the invention]

Hereafter, the present invention is explained concretely with the embodiments. In addition, % is weight % unless it is shown especially.

The surface-modified fine silica powder of the present invention is that the adsorption amount of the anion source compound to the surface-treated fine silica powder is more than 150% of that of original silica powder before the surface-treatment. The anion source compound means the compound that has the anion group combined with the amino group induced on the surface of the fine silica powder, for example, the sulfonate or the carboxylate etc. Concretely, as the sulfonate, toluenesulfonate, benzenesulfonate, and naphthalenesulfonate, such as sodium p-toluenesulfonate, sodium

benzenesulfonate, sodium 1-naphthalenesulfonate, sodium 2-naphthalenesulfonate, and 2 sodium 2,6-naphthalenesulfonate, can be used. As the carboxylate, benzoate and naphthalenecarboxylate, such as sodium benzoate, sodium p-methylbenzoate, sodium 1-naphthalenecarboxylate, sodium 2-naphthalenecarboxylate, can be used.

The surface-modified fine silica powder of the present invention shows the surface-modified degree by making the adsorption amount of the anion source compound as the index. Moreover, said fine silica powder has higher adsorption amount of the anion source compound than the untreated original powder. Specifically, the adsorption amount of the anion source compound is more than 150% of that of the original powder before the surface treatment. Since the surface-modified fine silica powder of the present invention has such high adsorption ability, when said fine silica powder is mixed in the ink acceptor layer etc., the blotting with ink can be prevented effectively. In addition, when this adsorption amount is less than 150%, the surface-treatment degree is not enough, and the blotting with ink etc. can not be prevented sufficiently.

As the example of the adsorption amount of the anion source compound, the adsorption amount of sodium benzenesulfonate is mentioned. The example of the surface-modified fine silica powder of the present invention is that the adsorption amount of sodium benzenesulfonate is more than 15% of the additive amount to the fine silica powder having basic amount. That is, as the concrete example, the fine silica powder is mentioned, in which said fine

silica powder can adsorb more than 15% of sodium benzenesulfonate, when 100ml of sodium benzenesulfonate aqueous solution having 2.5mmmol / g is added to 2g of the surface-treated fine silica powder. Regarding said fine silica powder, the adsorption amount after the surface-treatment is about more than 150% of that of the original powder before the surface-treatment in general. Regarding the fine silica powder being the adsorption amount of sodium benzenesulfonate of less than 15%, the blotting with ink can not be prevented sufficiently, when it is mixed in the ink acceptor layer.

In addition, the adsorption amount of the anion source compound can be determined, by measuring the amounts of the anion source compounds in the aqueous solutions before and after. Concretely, for example, the adsorption amount of the anion source compound to the fine silica powder can be determined by the way that the fine silica powder having constant amount is added to the anion source compound aqueous solution to be dispersed with stirring, and the fine silica powder is removed after the fixed time. Then, the concentrations of the anion source compounds contained in the aqueous solutions before adding the fine silica powder and after removing the fine silica powder, are measured by a spectrophotometer etc., to determine the adsorption amount of the anion source compound by this concentration difference.

The surface-modified fine silica powder of the present invention has the specific surface area of more than $50\text{m}^2/\text{g}$ by the BET method, preferably more than $200\text{m}^2/\text{g}$, more preferably $250\text{m}^2/\text{g}$. When this specific surface area is less than $50\text{m}^2/\text{g}$, the induced amount of the amino group per unit

surface area is limited at the time of surface-treating, so that the fine silica powder cannot have high adsorption ability to the anion source compound. Moreover, the fine silica powder by the vapor phase method having the specific surface area of more than 400m²/g, is not commercially produced now. When this specific surface area is too large, the induced amount of the amino group is restricted naturally. Therefore, it is suitable that the particle size of silica has the specific surface area of 50 to 400m²/g by the BET method.

Moreover, it is preferable that the surface-modified fine silica powder is the fine powder made by the vapor phase method, i.e., fumed-silica. Since the silica powder obtained by wet-process has the large agglomerated particles, it is difficult to modify uniformly with the amino-silane on the surface of particle. Therefore, the adsorption amount to the anion source compound becomes low. Moreover, since a transparent feeling does not come out when the ink acceptor layer is formed, it is not desirable. As the example of the production by the vapor phase method, the flame hydrolysis method using tetrachlorosilane as a raw material is known. As the silica powder made by the vapor phase method, for example, the products made by NIPPON AEROSIL Co., Ltd. (Tradenames are Aerosil 1200, Aerosil 1200CF, Aerosil 1300, Aerosil 1300CF, Aerosil 380, and Aerosil 380S), the product made by Cabot Co. (Tradename is Cabosil), the product made by Wacker Co. (Tradename is HDK), the product made by Tokuyama Co. (Tradename is Reorosil), etc., are used.

The fine silica powder made by the vapor phase method has the hydroxyl group on the surface, and although said fine silica powder has the

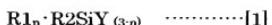
adsorption ability to the anion, its amount is low. The adsorption amount of the anion source compound is about several % to several 10 % in the case of the untreated fine silica powder. Therefore, the fine silica powder of the present invention is surface-treated, with the treatment reagent containing the amino group preferably, until the level showing that the adsorption amount is more than 150% of that of the untreated original powder.

As mentioned above, the surface-modified fine silica powder is surface-treated with the treatment reagent containing the amino group preferably, and its nitrogen content is more than 0.3%. When the nitrogen content is less than 0.3%, the adsorption ability to sodium benzenesulfonate is low, and the adsorption amount of more than 15% can not be obtained. In addition, regarding the amount of the amino group induced on the surface of silica by the surface-modified treatment, about 1% of nitrogen content is a limit from various conditions, and at this time, the adsorption amount of sodium benzenesulfonate is about 60%.

It is available that the amino group induced on the surface of the fine silica powder has any one or more kinds of the 1st class amine, the 2nd class amine, the 3rd class amine, or the 4th class ammonium salt. As such treatment reagent containing the amino group, an organic silicon compound is preferable, in which said silicon compound has at least one of the hydrolysis group or the silanol group connected directly with silicon atom in 1 molecule, and at least one of the hydrocarbon group having more than one of the amino group connected with silicon atom by carbon-silicon bond. By using such

organic silicon compound, these hydrolysis and silanol groups occur the condensation reaction with the silanol group on the surface of the fine silica powder by the hydrolysis etc., so that its formed compound is fixed chemically on the surface of fine silica powder. That is, the fine silica powder having the amino group on the surface can be obtained, by fixing the organic silicon compound having the amino group on the surface of the fine silica powder, and the anion compound can be adsorbed on the surface of silica by the cation property of the amino group.

As such organic silicon compound, for example, the organosilane shown in the following general formula [1] is suitable.



where, R1 is a monovalence hydrocarbon group, R2 is a hydrocarbon group having more than one of the amino group, Y is a hydrolysis group or a hydroxyl group, n is 0, 1, or 2.

This hydrolysis group (Y) etc. is connected with the silanol group etc. on the surface of fine silica powder to induce the amino group (R) on the surface of silica. Moreover, the hydrocarbon group (R1) etc. is connected with other hydrolysis group etc. to have high adsorption strength to the surface of silica.

As this organic silicon compound, for example, γ -aminopropyltrimethoxy silane, γ -aminopropyltriethoxy silane, γ (2-amino ethyl) aminopropyltrimethoxy silane, γ (2-amino ethyl) aminopropyltriethoxy

silane, N-phenyl- γ -aminopropyltrimethoxy silane, or N-phenyl- γ -aminopropyltriethoxy octadecyldimethyl(3-(trimethoxysilyl)propyl) ammoniumchloride, etc., can be used concretely. It is available that one or more than two kinds of these reagents can be used. By using more than two kinds of these reagents, the amino group having different reactivity can be induced on the surface. By inducing the amino group having different reactivity, the width of reactivity spreads rather than the case of surface-treating with one kind of the treatment reagent containing the amino group, and can correspond to more kinds of the anion source compound.

It is suitable that the using amount of the surface treatment reagent is more than 10mmol (10mmol / 100g), preferably more than 30mmol (30mmol / g), to 100g of the fine silica powder. When the using amount of the treatment reagent is less than this amount, the surface-treatment effect is not obtained sufficiently. In addition, the number of silanol, which reacts with the amino group in the silane compound containing the amino group, is almost constant per unit area on the surface of silica, and the amount of the induced amino group is limited for the three-dimensional obstruction of the coated alkyl group. Incidentally, the amount of nitrogen after the surface treatment is about 1% in general, even when the specific surface area of silica is large.

It is preferable that the surface-treatment is done by the dry-process. Conventionally, the wet-process is known in general, in which the silica is surface-treated in water by dropping amino silane to disperse (Journal of the

Japan Society of Colour Material, Vol. 55, No. 9, P630 - 636, 1986). However, by this wet-process, in the case of the silica made by the vapor phase method, since the viscosity increasing is very high, the silica cannot be dispersed in water with high concentration. Therefore, the surface-treatment may not be done uniformly. Moreover, in the wet-process, it is necessary to dry after the surface-treatment, so that the treatment process becomes complicated. Furthermore, at the time of drying, the agglomeration occurs easily between the silica particles by the capillary tube pressure, and pulverizing is necessary, so that it is not economical. In addition, in the treatment process using hydrophobic reagent, which is also the dry-process, the surface-treated silica is hydrophobic, and cannot be dispersed in water, so that this process is not suitable to the ink acceptor layer comprising the material like water. And said dry-process is preferably done under heating and vigorous stirring in nitrogen atmosphere.

Since the surface-modified fine silica powder is connected with the amino group on the surface, said fine silica powder having the specific surface area of 200 to 400m² / g by the BET method contains about 0.3 to 1.0% of nitrogen, and becomes the low viscosity slurry when it is used as the water slurry. For example, under pH of 3 to 6 and 15 to 30% of the silica concentration, the silica slurry has high flowability, in which the viscosity is less than 50mPa·s, preferably 1 to 50mPa·s. In addition, when the nitrogen content is less than 0.3%, the viscosity of the silica slurry in the standard range becomes more than 50mPa·s, so that the flowability decreases.

In the hydrophilic surface-modified fine silica powder of the present invention, when the ink acceptor layer coated on the surface of the printing paper is formed with the material like water, such as the slurry of the alcoholic solution etc., said surface-modified fine silica powder can be dispersed uniformly into this material, so that the excellent ink acceptor layer can be formed. When the silica is hydrophobic, the dispersibility to such a material like water is low, so that the preferable ink acceptor layer cannot be formed.

Moreover, by mixing the surface-modified fine silica powder with alcohol to become the silica slurry, the forming liquid of the ink acceptor layer can be obtained. It is suitable that the silica concentration of this liquid is 3 to 30%. When the surface-modified fine silica powder is less than 3%, the additive effect is a little, and when the surface-modified fine silica powder is more than 30%, the viscosity of the slurry becomes high. Therefore, they are not suitable for coating the solution uniformly. By coating this ink acceptor layer on the surface of the printing paper, such as the recording paper etc., the printing material suitable for ink-jets can be obtained.

[Example]

Hereinafter, the examples of the present invention are explained with the comparison examples. In addition, in these examples, the adsorption amount and hydrophilic of the anion source compound are measured with the following processes. The results of these examples 1 to 6 and the comparison examples 1 to 8 are shown in Table 1.

Measuring the adsorption amount

Sodium p-toluenesulfonate aqueous solution (2.5mmol/L) is put into a beaker, and added 2g of fine silica powders to disperse in this aqueous solution with stirring. After stirring for 5 minutes, this liquid is filtrated by a syringe having the filter, where a pore size is 0.45μm, and this filtrate is taken out the glass sample bottle to be extracted 1ml correctly with a measuring pipet, and this extracted liquid is put into the volumetric flask to be diluted with pure water to 100ml. Next, the transparency of the predetermined wavelength (220.8nm) light to the sample was measured using the spectrophotometer made by NIPPON BUNKO Co. (V-570). At this time, the quartz cell with capacity of 10mm adjusted to 100% with pure water was prepared, and pure water is put into a reference side and the above-mentioned diluted solution is put into a sample side. The measured value was calculated to obtain the adsorption amount by using the following formula (a). Then, the value of percentage of said calculated adsorption amount is determined as the sample adsorption amount. In addition, the adsorption amount of sodium benzenesulfonate can be calculated like above process. When the adsorption amounts of sodium benzoate and sodium 2-naphthalenesulfonate are measured instead of sodium p-toluenesulfonate, about sodium benzoate, the transparency is measured with the light of the wavelength of 224.0nm, and the adsorption amount is calculated with the following formula (b). About sodium 2-naphthalenesulfonate, transparency is measured with the light of the wavelength of 274.8nm, and the adsorption amount is calculated with the following formula (c). In addition, in the following formulas, Y is the concentration (mmol / L) of sodium p-toluenesulfonate in the extracted sample

liquid, X is transparency (%), and Z is the adsorption amount (mmol/L) to the silica.

- (a) $Y = -4.32 \ln(X) + 19.76$, $Z = 2.5 \cdot Y$
- (b) $Y = -5.42 \ln(X) + 24.86$, $Z = 2.5 \cdot Y$
- (c) $Y = -9.06 \ln(X) + 41.76$, $Z = 10 \cdot Y$

Hydrophilic evaluation

The hydrophilic is evacuated with the state, where the surface-modified fine silica powder is dispersed in water. Concretely, about 2g of the surface-modified fine silica powder is put into the beaker having capacity of 300ml, and 100ml of pure water is added to stir for one minute with the magnetic stirrer. Then, the fine silica powder, which floats on water, is determined as the hydrophilic powder.

Measuring the nitrogen content

The sample is oxidized at high temperature, and the generated NOx reacts with ozone to become the excited state. By measuring the light with the all nitrogen analysis equipment made by Mitsubishi Kagaku Co. (Trade name is TN-10) at the time of dropping the ground state from the excited state, the nitrogen content is determined.

Example1

100g of the silica powder synthesized by the vapor phase method and having the specific surface area of $200\text{m}^2/\text{g}$ by the BET method, in which its tradename was Aerosil1200, was put into the mixer. While stirring under

nitrogen atmosphere, 20mmol / 100g of N- β -(aminoethyl)- γ -aminopropyltrimethoxy silane dissolved in the same weight of methanol, in which said silane was made by the SHINETSU KAGAKU Co. and its tradename was KBM603, was dropped onto the silica powder. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing a volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. The adsorption amount of sodium p-toluenesulfonate to this fine silica powder was 22%. In addition, the adsorption amount before the surface-treatment was 12%, and therefore, the adsorption amount after the surface-treatment was 183% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.50%.

Example2

100g of the silica powder synthesized by the vapor phase method and having the specific surface area of 380m² / g by the BET method, in which its tradename was Aerosil1380S, was put into the mixer. While stirring under nitrogen atmosphere, 53mmol / 100g of γ -aminopropyltrimethoxy silane dissolved in the same weight of methanol, in which said silane was made by the SHINETSU KAGAKU Co. and its tradename was KBE903, was dropped onto the silica powder. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing the volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. The adsorption amount of sodium benzoate to this fine silica powder was 29%. In addition, the adsorption amount before the surface-treatment was 15%, and

therefore, the adsorption amount after the surface-treatment was 193% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.56%.

Example 3

100g of the silica powder synthesized by the vapor phase method and having the specific surface area of 380m² / g by the BET method, in which its tradename was Aerosil 380S, was put into the mixer. While stirring under nitrogen atmosphere, 20mmol / 100g of γ -aminopropyltrimethoxy silane and 30mmol / 100g of γ (2-aminoethyl) aminopropyltrimethoxy silane, which were dissolved in the same weights of methanol, were dropped simultaneously, in which the former silane was made by the SHINETSU KAGAKU Co. and its tradename was KBE903, and the later silane was made by Dow Corning Toray Silicone Co. and its tradename was SH6020. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing the volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. The adsorption amount of sodium 2-naphthalenesulfonate to this fine silica powder was 14%. In addition, the adsorption amount before the surface-treatment was 8%, and therefore, the adsorption amount after the surface-treatment was 175% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic.

Comparison Example 1

100g of the silica powder synthesized by the vapor phase method and having the specific surface area of 300m² / g by the BET method, in which its

tradename was Aerosil 1300, was put into the silica powder. While stirring under nitrogen atmosphere, 8mmol / 100g of γ -aminopropyltrimethoxy silane dissolved in the same weight of methanol, in which said silane was made by the SHINETSU KAGAKU Co. and its tradename was KBM903, was dropped onto the silica powder. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing the volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. This surface-modified silica powder was hydrophilic. However, the adsorption amount of sodium p-toluenesulfonate to this fine silica powder was 15%, In addition, the adsorption amount before the surface-treatment was 8%, and therefore, the adsorption amount after the surface-treatment was 125% of that before the surface-treatment. Moreover, the nitrogen content was 0.10%.

Comparison Example 2

100g of the silica powder synthesized by the vapor phase method and having the specific surface area of 380m² / g by the BET method, in which its tradename was Aerosil 380S, was put into the mixer. While stirring under nitrogen atmosphere, 8mmol / 100g of γ -aminopropyltrimethoxy silane dissolved in the same weight of methanol, in which said silane was made by the SHINETSU KAGAKU Co. and its tradename was KBE903, was dropped onto the silica powder. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing the volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. This surface-modified silica powder was hydrophilic. However, the adsorption amount of sodium benzoate to this fine silica powder was 19%, In addition, the

adsorption amount before the surface-treatment was 15%, and therefore, the adsorption amount after the surface-treatment was 127% of that before the surface-treatment. Moreover, the nitrogen content was 0.09%.

Comparison Example 3

100g of the silica powder synthesized by the vapor phase method and having the specific surface area of 300m² / g by the BET method, in which its tradename was Aerosil 1300, was put into the mixer. While stirring under nitrogen atmosphere, 4mmol / 100g of γ -aminopropyltrimethoxy silane and 4mmol / 100g of γ -(2-aminoethyl) aminopropyltrimethoxy silane, which were dissolved in the same weight of methanol, were dropped simultaneously, in which the former silane was made by the SHINETSU KAGAKU Co. and its tradename was KBM903, and the later silane was made by Dow Corning Toray Silicone Co. and its tradename was SH6020. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing the volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. This surface-modified silica powder was hydrophilic. However, the adsorption amount of sodium 2-naphthalenesulfonate to this fine silica powder was 10%, In addition, the adsorption amount before the surface-treatment was 8%, and therefore, the adsorption amount after the surface-treatment was 125% of that before the surface-treatment. Moreover, the nitrogen content was 0.08%.

Example 4

100g of the silica powder synthesized by the vapor phase method and

having the specific surface area of 380m² / g by the BET method, in which its tradename was Aerosil 380S, was put into the mixer. While stirring under nitrogen atmosphere, 70mmol / 100g of γ (2-aminoethyl)aminopropyltrimethoxy silane dissolved in the same weight of methanol, in which said silane was made by Dow Corning Toray Silicone Co. and its tradename was SH6020, was dropped onto the silica powder. Then, the mixed powder was heated at 200°C for one hour with stirring. After removing the volatile component, said mixed powder was cooled to be obtained the surface-modified fine silica powder. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 58%. In addition, the adsorption amount before the surface-treatment was 19%, and therefore, the adsorption amount after the surface-treatment was 305% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.95%.

Example 5

The surface-modified fine silica powder was obtained like Example 4 excepting that 100g of the silica powder synthesized by the vapor phase method and having the specific surface area of 200m² / g by the BET method, in which its tradename was Aerosil 200CF, and 32mmol / 100g of γ aminopropyltrimethoxy silane made by the SHINETSU KAGAKU Co, in which its tradename was KBE903, were used. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 17%. In addition, the adsorption amount before the surface-treatment was 10%, and therefore, the adsorption amount after the surface-treatment was 170% of that before the

surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.32%.

Example 6

The surface-modified fine silica powder was obtained like Example 4 excepting that the silica powder synthesized by the vapor phase method and having the specific surface area of 300m² / g by the BET method, in which its tradename was Aerosil300 was used, and 20mmol / 100g of γ -aminopropyltrimethoxy silane and 20mmol / 100g of γ (2-aminoethyl)aminopropyltrimethoxy silane, which were dissolved in the same weight of methanol, were dropped simultaneously, in which the former silane was made by the SHINETSU KAGAKU Co. and its tradename was KBM903, and the later silane was made by Dow Corning Toray Silicone Co. and its tradename was SH6020. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 38%. In addition, the adsorption amount before the surface-treatment was 15%, and therefore, the adsorption amount after the surface-treatment was 253% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.68%.

Comparison Example 4

The surface-modified silica powder was obtained like Example 4 excepting that the dropping amount of γ (2-aminoethyl)aminopropyltrimethoxy silane to 100g of the silica powder, was 28mmol / 100g, in which said silane was made by Dow Corning Toray Silicone Co. and its

tradename was SH6020, and the silica powder was synthesized by the vapor phase method, had the specific surface area of 380m² / g by the BET method, and its tradename was Aerosil 380S. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 13%. In addition, the adsorption amount before the surface-treatment was 19%, and therefore, the adsorption amount after the surface-treatment was 68% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.28%.

Comparison Example 5

The surface-modified silica powder was obtained like Example 5 excepting that the dropping amount of γ -aminopropyltriethoxy silane to 100g of the silica powder, was 28mmol / 100g, in which said silane was made by SHINETSU KAGAKU Co. and its tradename was KBE903, and the silica powder was synthesized by the vapor phase method, had the specific surface area of 200m² / g by the BET method and its tradename was Aerosil200CF. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 11%. In addition, the adsorption amount before the surface-treatment was 10%, and therefore, the adsorption amount after the surface-treatment was 110% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.18%.

Comparison Example 6

The surface-modified silica powder was obtained like Example 6 excepting that the dropping amount of γ -aminopropyltrimethoxy silane and

γ -(2-aminoethyl) aminopropyltrimethoxy silane to 100g of the silica powder, were 12mmol / 100g respectively, in which the former silane was made by SHINETSU KAGAKU Co and its tradename was KBE903, and the later silane was made by Dow Corning Toray Silicone Co and its tradename was SH6020, and the silica powder was synthesized by the vapor phase method, had the specific surface area of 300m² / g by the BET method, and its tradename was Aerosil 300. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 12%. In addition, the adsorption amount before the surface-treatment was 15%, and therefore, the adsorption amount after the surface-treatment was 80% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.23%.

Comparison Example 7

The surface-modified silica powder was obtained like Example 5 excepting that the dropping amount of γ -aminopropyltrimethoxy silane to 100g of the silica powder, was 30mmol / 100g, and hexamethyldisilazane was 5mmol / 100g, in which said silane was made by SHINETSU KAGAKU Co and its tradename was KBE903, and the silica powder was synthesized by the vapor phase method, had the specific surface area of 200m² / g by the BET method, and its tradename was Aerosil 200CF. This surface-modified silica powder was hydrophilic, and the adsorption amount of sodium benzenesulfonate to this fine silica powder could not be measured. The nitrogen content of this silica powder was 0.22g.

Comparison Example 8

The surface-modified fine silica powder was obtained like Example 4 excepting that 100g of the silica powder synthesized by the vapor phase method, having the specific surface area of 150m² / g by the BET method, was used, in which its tradename was Aerosil 150, and the dropping amount of γ(2-aminoethyl) aminopropyltrimethoxy silane was 400mmol / g, in which said silane was made by Dow Corning Toray Silicone Co. and its tradename was SH6020. The adsorption amount of sodium benzenesulfonate to this fine silica powder was 10%. In addition, the adsorption amount before the surface-treatment was 8%, and therefore, the adsorption amount after the surface-treatment was 125% of that before the surface-treatment. Moreover, this surface-modified silica powder was hydrophilic, and the nitrogen content was 0.12%.

Example 7

25 weight parts of the surface-modified fine silica powder prepared in Example 4 was dispersed in the solution by the wet jet mill to prepare the silica slurry, where the solution comprised 10 weight parts of polyvinyl alcohol made by Kuraray Co. and having the tradename as PVA220, 70 weight parts of water, and 5 weight parts of acetic acid. pH of this slurry solution was 4.5. Moreover, the viscosity was 1 to 15mPa·s at 22°C and the sharing speed of 0.15 to 100 / sec. Water and polyvinyl alcohol were added to this silica slurry solution until that the silica concentration became 13% and polyvinyl alcohol concentration became 10%, and said mixed solution was dispersed by the homogenizer to make the forming liquid of the ink acceptor layer. This forming

liquid was coated on a non coated ink jet paper by the bar coater method to make the layer thickness of 8 μ m after drying, in which the non coated paper was made by Mitsubishi Paper Mills Ltd. and its tradename was IJ-L. When this paper was printed by using the color ink jet printer made by Canon Co. and having the tradename as BJF-600, there were no cracking of coating film and blotting with ink.

Comparison Example 9

The silica slurry solution was prepared like Example 7 excepting that 25 weight parts of the surface-modified fine silica powder prepared in Comparison Example 4 were used. pH of this solution was 3.9, and the viscosity was measured to be 40 to 160mPa·s by the same process as Example 7. In addition, water and polyvinyl alcohol are added to this silica slurry solution until that the silica concentration was 13% and polyvinyl alcohol concentration was 10%, and said mixed solution was dispersed by the homogenizer to make the forming liquid of the ink acceptor layer. When the paper coated this forming liquid like Example 4 was printed like Example 7, there were no cracking of coating film, but some blotting with ink were observed.

[Effectiveness on industry]

The surface-modified fine silica powder of the present invention has the excellent effect as the mixing material of the printing material. When said fine silica powder is mixed to use for the ink acceptor layer, there are no blotting with ink and cracking of coating film etc., and the excellent printing effect can be obtained. Specifically, in the printing by the ink-jet, there is no blotting with ink, and excellent clear nature and fixing of ink are obtained.

Table 1

No.	Specific Surface Area of Silica	Surface treatment Reagent Kinds	Amount	Anion Source Compound	Adsorption Amount of Treated Powder	Adsorption Amount of Untreated Original Powder	Ratio of Adsorption Amounts	Nitrogen Content %
Example 1	200	N-(2-aminoethyl)γ-aminopropyltrimethoxy silane	20	Sodium p-toluenesulfonate	22	12	183	0.50
Example 2	380	γ-aminopropyltrimethoxy silane	53	Sodium benzoate	29	15	193	0.56
Example 3	300	γ-aminopropyltrimethoxy silane γ-(2-aminoethyl)aminopropyltrimethoxy silane	30 30	Sodium 2-naphthalensulfonate	14	8	175	0.92
Comparison Example 1	200	γ-aminopropyltrimethoxy silane	8	Sodium p-toluenesulfonate	15	12	125	0.10
Comparison Example 2	380	γ-aminopropyltriethoxy silane	8	Sodium benzoate	19	15	127	0.09
Comparison Example 3	300	γ-aminopropyltrimethoxy silane γ-(2-aminoethyl)aminopropyltrimethoxy silane	4 4	Sodium 2-naphthalensulfonate	10	8	125	0.08
Example 4	380	γ-(2-aminoethyl)aminopropyltrimethoxy silane	70	Sodium benzenesulfonate	58	19	305	0.95
Example 5	200	γ-aminopropyltriethoxy silane	32	Sodium benzenesulfonate	17	10	170	0.32
Example 6	300	γ-aminopropyltriethoxy silane γ-(2-aminoethyl)aminopropyltrimethoxy silane	20 20	Sodium benzenesulfonate	38	15	253	0.68
Comparison Example 4	380	γ-(2-aminoethyl)aminopropyltrimethoxy silane	28	Sodium benzenesulfonate	13	19	68	0.28
Comparison Example 5	200	γ-aminopropyltriethoxy silane	28	Sodium benzenesulfonate	11	10	110	0.18
Comparison Example 6	300	γ-aminopropyltriethoxy silane γ-(2-aminoethyl)aminopropyltrimethoxy silane	12 12	Sodium benzenesulfonate	12	15	80	0.23
Comparison Example 7	200	γ-aminopropyltriethoxy silane hexamethyldisilazane	30 5	Sodium benzenesulfonate	—	10	—	0.22
Comparison Example 8	150	γ-(2-aminoethyl)aminopropyltrimethoxy silane	40	Sodium benzenesulfonate	10	8	125	0.12

(Note) Specific Surface Area is the value by the BET method (m^2/g). Amount of Surface-treatment Reagent is mmol/100g. Adsorption Amounts of Treated Powder and Untreated Original Powder are %. Ratio of Adsorption Amounts is the ratio (%) of the adsorption amount after the surface-treatment to the adsorption amount of the original powder before the surface-treatment.

[What is claimed is]

[1] A surface-modified fine silica powder for adsorbing the anion source compound,

wherein the adsorption amount of the anion source compound to the surface-treated fine silica powder is more than 150% of that of the original powder before the surface-treatment.

[2] The surface-modified fine silica powder according to claim [1], wherein the anion source compound is the sulfonate or the carboxylate, and its adsorption amount is more than 150% of that of the original powder before the surface-treatment.

[3] The surface-modified fine silica powder according to claim [1], wherein the anion source compound is sodium benzenesulfonate, and its adsorption amount is more than 15% of the additive amount to the fine silica powder.

[4] The surface-modified fine silica powder according to claim [1], wherein the nitrogen content is 0.3 to 1.0%, and the adsorption amount of sodium benzenesulfonate is 15 to 60%, after the surface-treatment

[5] The surface-modified fine silica powder according to any one of claims [1] to [4], wherein the adsorption amount of the anion source compound is made to more than 150% of that of the original powder before the surface-treatment, by surface-treating with a treatment reagent containing amino group comprising the organic silicon compound having the hydrolysis group or the silanol group combined with silicon atom, and more than one kind of amino group.

[6] The surface-modified fine silica powder according to claim [5],

wherein the treatment reagent containing amino group is surface-treated with an organosilane shown in the general formula [1] of $(R1)_n \cdot (R2)SiY_{(3-n)}$, where R1 is a monovalence hydrocarbon group, R2 is a hydrocarbon group containing more than one kind of the amino group, Y is a hydrolysis group or a hydroxyl group, and n is 0, 1, or 2.

[7] The surface-modified fine silica powder according to claim [6], wherein 100g of the fine silica powder is surface-modified under dry-process using more than 10mmol of one or more than two kinds of organosilane shown in the formula [1].

[8] The surface-modified fine silica powder according to any one of claims [1] to [7],

wherein the original fine silica powder is fumed-silica having the specific surface area of 50 to 400m² / g by the BET method.

[9] The surface-modified fine silica powder according to any one of claims [1] to [8],

wherein said fine silica powder is hydrophilic, and is used as the material of the ink acceptor layer of the printing material.

[10] A low viscosity silica slurry comprising the fine silica powder according to claim [1],

wherein the adsorption amount of the anion source compound is more than 150% of that of the original powder before the surface-treatment, the specific surface area is 200 to 400m² / g by the BET method, nitrogen content is 0.3 to 1.3%, and the viscosity is 1 to 50mPa·s under pH of 3 to 6 and the silica concentration is 15 to 30%.

[11] A forming material of the ink acceptor layer containing 5 to

30% of the surface modified fine silica powder according to any one of claims [1] to [10].

[12] An ink jet printing material coated with the liquid comprising the material of the ink acceptor layer according to claim [11].

Abstract

A surface modified fine silica powder which has been treated, preferably, with a treating agent containing an amino group, characterized in that the powder exhibits an adsorption amount for an anion source compound of 150 % or more of that of an original powder which has not been treated; and a printing material using the silica powder. The surface modified fine silica powder can provide an excellent printed matter being free from blotting with ink or a cracking of coating film.

Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先、国籍は下記の私の氏名の後に記載された通りです。

My residence, mailing address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

上記発明の明細書は、

SURFACE-MODIFIED FINE SILICA POWDER AND USE THEREOF

本書に添付されています。

the specification of which

is attached hereto.

____月____日に提出され、米国出願番号または特

was filed on March 22, 2002

許協定条約国際出願番号を

as United States Application Number or PCT International Application Number

_____とし、

10/088,101 and was amended on

(該当する場合) _____に訂正されました。

_____ (if applicable)

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

Japanese Language Declaration (日本語宣言書)

私は、米国法典第35編119条(a) - (d)項又は365条 (b)項に基づき下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約365(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

**Prior Foreign Application(s)
外国での先行出願**

11-268565	Japan
(Number) (番号)	(Country) (国名)

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(Application No.) (出願番号)	(Filing Date) (出願日)
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私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条 (c)に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

PCT/JP00/06507	September 22, 2000
(Application No.) (出願番号)	(Filing Date) (出願日)

(Application No.) (出願番号)	(Filing Date) (出願日)
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私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby claim foreign priority under Title 35, United States Code, § 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Claimed 優先権主張	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Yes はい	No いいえ	

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)
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I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Status: Patented, Pending, Abandoned) (現況:特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned) (現況:特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration
(日本語宣言書)

委任状：私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
 (弁護士、または代理人の指名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)



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Japanese Language Declaration
(日本語宣言書)

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